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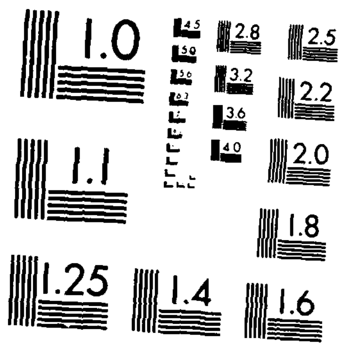

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MUSCULOSKELETAL INJURY:

RISKS PREVENTION AND FIRST AID

AUTHORS:

Bruce H. Jones, M.D., M.P.H.

and

Paul B. Rock, D.O., Ph.D.
US Army Research Institute of
Environmental Medicine
Natick, MA 01760-5007

Michael P. Moore, M.D.
Walter Reed Army Medical Center
Washington, DC 20307

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MUSCULOSKELETAL INJURY: RISKS, PREVENTION AND FIRST AID

Musculoskeletal injury is an inherent risk of any vigorous physical activity including exercise testing and training. Although the risk of injury can never be completely eliminated, many potential injuries may be prevented by eliminating specific risk factors and using " common sense" during exercising. If injuries occur in spite of preventive measures, early recognition and appropriate treatment can help limit the extent of the injury and its impact on further activity.

RISK OF INJURY

In order to prevent injury, risks must first be identified, then modified or circumvented. Although much information exists on the treatment of exercise related injuries, there is little information on risk factors, even for common injuries. In a statistical sense, the relative risks are determined by comparing the injury rate (number of individuals injured divided by the total number of injured and uninjured individuals) of groups exposed to a putative risk factor with similar groups which have not been exposed. Most articles purporting to identify risk factors are "case series" studies which report only the number of injured and, therefore, do not permit calculation of injury rates for comparison.

In spite of the lack of information needed to clearly document risks associated with various physical activities, a number of factors have been identified which are felt to constitute risks for injury during exercise.

The focus of this section is on the risks of injury associated with aerobic activities such as walking and running, but the general principles and strategies discussed can be applied to all repetitive weight-bearing activities including games and sports like tennis and soccer. Management of risks will be discussed, but because of our imprecise knowledge of risk factors only general preventive strategies will be outlined.

Extrinsic and intrinsic risk factors for musculoskeletal or "biomechanical" injuries are listed in Table 1. Extrinsic risk factors are variables outside the individual (environmental factors, terrain features, equipment etc.) while intrinsic factors are inherent characteristics of the individual (age, sex, weight, percent body fat etc.). Of all the variables associated with exercise, training factors particularly frequency and duration of exercise are the most amenable to modification and may be the most important variables to adjust to prevent injury. In untrained individuals, frequency of exercise above 3 days per week, and/or durations of greater than 30 minutes per session are associated with greatly increased injury rates and minimal gains in aerobic capacity (Table 2). Injury rates among distance runners and joggers increase with increasing mileage, even though there are fewer injuries per mile for the high mileage runners. Exercise intensity (level of effort) is undoubtedly also a significant risk factor, but the relationship has not been clearly documented.

There are no good data on the effects of playing surface or terrain on injury rates. Common sense, would suggest that different surfaces are associated with different risks of injury. For runners there maybe a trade off between the increased shock absorbancy of grass or dirt trails and the

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increased risk of traumatic injuries from the irregularity of these surfaces. Common sense and practicality should dictate the choice of where to exercise.

In regard to footwear, again there is no experimental or epidemiologic data demonstrating that any one type of footwear (athletic or running shoe) protects the wearer from injury. It is difficult to believe that today's better designed shoes are not protective, however.

One intrinsic factor which may predispose to injury is low fitness level. Evidence to support this conclusion comes from military data which suggest that men and women who fall into the lowest two quartiles of aerobic fitness as measured by entry level mile run times are more likely to be injured than their more physically fit counterparts (2.5 and 1.5 times more likely, respectively). Data such as these suggest that sedentary, relatively "unfit" individuals are more likely to suffer injuries when exposed to routine high intensity (relative to the current fitness level) physical training.

Obesity is thought to increase injury rates because the increased fat relative to lean body mass (muscle and bone) causes greater physiologic and biomechanical stress during weight-bearing exercise. While the relationship of obesity to injury has not been quantified, it seems reasonable that careful structuring of exercise routines would limit the risks of injury for overweight individuals. In some instances non-weight-bearing activities like swimming or biking may be preferable initially. Weight reduction to decrease the fat to lean body ratios may also help prevent injuries. It is recommended that weight reduction programs should combine dieting and exercise to be effective (see American College of Sports Medicine Position Statement on Proper and Improper Weight Loss Programs).

Female sex has also been implicated as a risk factor for training injuries, but the data is not clear. Military studies indicate that female recruits engaged in "total fitness" programs similar to those for males report for medical attention for musculoskeletal injuries almost twice as often as males (see Table 3). Also, more women than men runners have requested medical attention for acute musculoskeletal injuries following the Boston Marathon in the last several years. However, a recent Center for Disease Control survey indicated that overall injury rates were similar for women and men runners (38% per year), although women sought medical care more frequently than men over a year's period of time suggesting that women may be more likely than men to seek medical attention for similar conditions or that the injuries that they suffer are more serious.

It is also likely that lower physical fitness higher levels of body fat and perhaps some anatomic factors may explain the excess injuries among women. Whatever the case, modulating exercise in accord with the individual's fitness level and body composition should help to minimize any apparent excess risk.

Age is another purported risk factor for injury which has not been documented. While aerobic capacity and other fitness parameters have been demonstrated to decrease with increasing age, injury rates have not been shown to systematically increase among older exercise participants. Several studies of medical casualties during marathons have shown just the opposite, i.e., acute musculoskeletal injury rates following these races decrease consistently with increasing age (Table 4). These data may reflect judicious pacing and a greater inclination to stop exercise when warning signs are perceived in older individuals. Age is clearly <u>not</u> a contraindication to vigorous exercise, however, discretion should be used in programming intensity and other training parameters for older individuals.

Among the most frequently cited intrinsic causes of injury are anatomic variants such as flat feet (pes planus), high arches (pes cavus), bowed legs (genu varum) etc. Ironically, none of the conditions has been clearly demonstrated to confer excess risk. Circumstantial evidence that they do is strong, however. Unless an individual with an anatomic variant is bothered by discomfort or pain there is no reason to seek medical consultation or to curtail activity for one of these anomalies. In some instances orthopedic or podiatry interventions like orthotics may be appropriate.

The role of minor injuries in causing other injuries is also not well documented, but it is probably only a small effect. It is clear however, that serious or severe past injuries (i.e., torn cartilage or ligaments, severely sprained ankles, fractures, etc.) may result in residual structural weaknesses that undoubtedly predispose to re-injury. Common sense and the presence of discomfort should dictate the level and amount of exercise in people with recent injuries.

As more older individuals begin to exercise, the question of how degenerative joint diseases such as osteoarthritis and rheumatoid arthritis affect injury rates and exercise tolerance becomes increasingly important. Exercise is not precluded in either of these conditions, although weight-bearing activities may be contraindicted. It may be best to prescribe non-weight-bearing exercise for these individuals. Furthermore, individuals whose functional activities are impaired as a result of these and similar conditions should seek medical advice prior to initiating an exercise routine.

INJURY PREVENTION STRATEGIES

Although certain intrinsic or extrinsic factors appear to increases risk of injury during exercise, we still have very limited understanding of the underlying causal mechanisms. For this reason, it is difficult to devise precise preventive measures for specific injuries, so a general preventive strategy aimed at broad categories of risk and a variety of injuries must suffice. This strategy includes: individualized exercise programs based on fitness and risk assessment, monitoring for signs of impending injury, appropriate use of warm-up, stretching and cool down periods and use of proper equipment.

Individualization of exercise. Risk factors must be taken into account in tailoring an exercise program. The type of exercise and its intensity, duration and frequency must all be considered along with the person's exercise goals and his ability to tolerate both physiologic and biomechanical stress.

Special care should be exercised for very sedentary or obese individuals. Prudence dictates that initial training in particular should be of low intensity and duration to give both the cardiovascular and musculoskeletal systems time to accommodate to the new stresses of exercise (in chapter three of Guidelines for Exercise Testing and Prescription). For individuals with limiting mechanical risk factors (i.e., anatomic malalignment, injury, arthritis, or obesity) it may be wise to recommend non-weight-bearing physical activities like swimming or biking.

Warning signs. Exercising individual should routinely monitor themselves for signs of impending injury. Fatigue and lack of enthusiasm for training are frequently indicators that exercise has been too intense or that rest and recovery have been inadequate. The remedy is increased rest and decreased intensity of training.

Pain is another important warning sign. It usually indicates that a body part is being over-stressed. Pain that develops precipitously and is severe, or that gradually but consistently increases on successive days should be heeded and training curtailed until the pain improves or abates. Also, discomfort accompanied by changes in function (limping gait, etc.) requires modification of the exercise program. Individuals with recent severe injuries, musculoskeletal disease, or clear anatomic malalignment should pay particular attention to these warning signs.

Warm-up, stretching, and cool-down. Although clear-cut evidence of its efficacy is lacking, warming up is recommended as a means of preventing injury and increasing performance. Current opinion is that the warm-up should involve the major muscle groups used in the physical activity. The warm-up should increase gradually in intensity to levels near that of the proposed work-out. Five to ten minutes of steady state exercise are usually required to raise muscle temperature to optimal levels. At the end of the 5 or 10 minutes of initial warm-up (walking or slow running) another 5 or 10 of calesthenics may be beneficial.

Non-ballistic (non-bouncing) stretching exercise are also recommended even though their efficacy has also not been proven. For individuals performing weight-bearing activity the focus of this stretching should be the low-back, hamstrings (posterior thigh), and the calf muscles of the leg (gastroc-soleus complex). A text book or training manual for the particular sport of interest should be consulted for specific stretching routines.

The cool-down, like the warm-up, is thought to be beneficial in preventing injuries. It should allow for a gradual cooling of the major muscle groups involved in prior exercise. This allows the blood vessels to contract gradually decreasing the likelihood of fainting as a result of blood pooling in the leg muscles when exercise suddenly stops. The cool-down coupled with gentle stretching is also thought to help decrease post exercise muscle soreness and stiffness.

Equipment. The most important piece of equipment for weight-bearing activities (walking, running, tennis, soccer, etc.) is a good shoe. Shoes are now specifically designed and engineered for particular sports, with the goal of improving performance and preventing injuries. Footwear is particularly important for running, where each foot may impact with the pavement 1000 times per mile. According to current thinking, a good running shoe should have a durable, flexible, and shock absorbent sole, an elevated, stable heel counter, and a comfortable insole. Most importantly the shoe should fit the individual's foot (see article by Bates in references on how to choose a good shoe). Maintenance of shoes is also important in injury prevention. Wearing shoes with excessive wear on the outside or inside of the heels is comparable to having an anatomic defect of the foot. Badly worn shoes should be replaced.

ACUTE AND CHRONIC INJURIES

Exercise induced injuries can be broadly classified as either acute (traumatic) or chronic ("overuse") injuries. Acute injuries result when ligaments, bones, or muscle-tendon units are subjected to an abrupt force which exceeds their stress-strain threshold or yield point. Forces which exceed that yield point cause mechanical deformation of the structure resulting in failure and injury. Acute injuries usually result from single violent events like twisting an ankle in a pot hole or breaking a bone in a collision between two soccer players.

Overuse injuries result from small repetitive overload forces on the structural (bones, ligaments and tendons) and force generating (muscles) elements of the body. With weight-bearing activities like running, microtraumatic events which slightly exceed the body's ability to repair itself accumulate foot-step after foot-step, mile after mile. Eventually the accumulation of these slight insults results in a noticeable injury. Because it is necessary to overload not only the cardiovascular but also the musculoskeletal system to achieve a training effect these injuries are bound to occur to some extent with any exercise program. The majority of overuse injuries to the musculoskeletal system are soft tissue injuries.

Acute injuries

The two most common traumatic injuries encountered in exercise setting are sprains (ligament) and strains (muscle).

Sprains. Injuries to ligaments are termed "sprains". Ligaments are fibrous connective tissue that connect bones or cartilage providing support and strength to joints. Sprains are conventionally classified into three categories - first, second and third degree depending on the severity of ligament tearing. First degree sprains result from minimal tearing of the ligament and are characterized by microfailure of collagen fibers within the ligament. There is no associated joint instability, and only mild pain and swelling. Second degree sprains are more severe with partial tearing of the ligament and possibly the joint capsule. Second degree sprains may be associated with varying degrees of joint instability, although instability may not be apparent if there is associated muscle spasm. There is substantial damage to the collagen fiber and considerable loss of strength of the ligament with second degree sprains. These injuries are characterized by severe pain and marked swelling. A second degree sprain that is inadequately treated may result in further injury or complete tearing of the ligament.

Third degree sprains result from a complete tear of the ligament. These injuries are characterized by severe pain at the time of injury and obvious joint instability. Injuries of this severity often require surgical reconstruction and stabilization. They require prompt evaluation by an orthopedic surgeon.

Strains. Strains are commonly referred to as "muscle pulls" and generally result from stretching or tearing of muscle. They are classified by the severity of muscle damage and resulting loss of function. First degree strains produce only mild signs and symptoms with is minimal local pain which is increased with passive stretch or vigorous contraction of the injured muscle. Often with mild strains only a sensation of muscle tightness with activity is present. Second degree strain is a more severe injury with partial tearing of the injured muscle. There is substantial pain and considerable loss of function. With second degree strains there may be varying degrees of hemorrhage and discoloration from bruising. Third degree muscle strains cause marked muscle disruption and possible avulsion of the muscle-tendon unit. These injuries may require surgical intervention and should be promptly evaluated by an orthopedic surgeon.

Muscle strains are common injuries, particularly in the lower extremity where the hamstring musculature and the calf muscles are the groups most commonly injured. Most strains of the lower extremity are mild to moderate in severity but may require up to three weeks for recovery. More severe muscle strains may require several months to heal. Muscle strains often recur, particularly if there has been inadequate rehabilitation, since the inelastic scar tissue which forms at the site of injury impairs flexibility. For this reason it is felt that both flexibility and strength of the injured muscle should be restored to near normal prior to return to previous levels of activity.

Other acute injuries. More serious, but less frequent acute injuries include fractures (broken bones) and dislocations (separation of joints). These and result in severe pain, swelling, and weakness. Suspected fractures should be immobilized (splinted) to prevent further separation of bone fragments and damage to blood vessels and nerves. Dislocated joints should also be immobilized. Individuals with these ailments should then be transported immediately to a hospital for evaluation and treatment.

Overuse Injuries

Overuse injuries can affect the bursae (bursitis), tendons (tendonitis and tenosynovitis), muscle (strains), ligaments (sprains), and bones (stress fractures).

Bursitis. The diagnosis of bursitis refers to the presence of inflammation of a known bursa. A bursa is a fluid filled sac which functions to reduce friction between adjacent tissues and is located where muscle or tendon pass over a bony prominence.

The key symptoms of bursitis are pain and limitation of motion. Signs of bursitis include point tenderness over the bursa,swelling and limited motion. Occasionally an inflamed bursa will appear red (errythematous) and warm. The majority of bursitis cases result from acute and/or chronic mechanical irritations or trauma; although acute septic bursitis requiring antibiotic therapy should also be considered. Treatment of bursitis consists of rest, ice application, and anti-inflammatory medication.

Tendenitis. Tendenitis refers to painful inflammation of a tendon which may be acute or chronic. It results from repetitive stress of forceful muscle contractions which leads to overload of the tendon and "mechanical fatigue" with micro-tears (microfailure). Excessively violent force may cause a complete tear or rupture of the tendon.

Overload of tendons is greater with eccentric (lengthening) muscle contractions such as occur running down hill or lowering a weight than with concentric contraction (shortening).

Force overload is believed to be a major etiologic factor in the development of such conditions as achilles tendenitis, tennis elbow (lateral epicondylitis), rotator cuff tendenitis and jumper's knee (patellar tendenitis). Tendenitis may be classified by the presence or absence of activity related pain and its severity. In the initial stage the primary complaint is pain. Repeated stress results in progressive inflammation which is characterized by mild pain prior to activity which generally improves with exercise and frequently reappears following activity. This stage is characterized by varying degrees of point tenderness of the tendon at the site of injury and pain with passive stretching. Progressive inflammation results in continuous activity pain which heralds more serious pathology of the tendon. If recovery is not allowed to occur, pain frequently prohibits the individual from participation in exercise or sports. This degree of inflammation is characterized by swelling, point tenderness and considerable pain to stretch of the tendon. Treatment consists of rest, ice massage of the tendon, and anti-inflammatory medication. The goal of treatment is pain free activity and restored flexibility.

Patellofemoral syndrome. One of the most common overuse injuries encountered in exercise programs is knee pain. The most common cause of overuse knee pain is the patellofemoral pain syndrome. This syndrome is particularly common among individuals participating in running programs, and frequently is referred to as "runner's knee". The term "chondromacacia" is often inappropriately used to describe overuse knee pain. However, chondromalacia literally means "soft cartilage" and specifically describes the pathology and appearance of deteriorating cartilage.

The etiology of patellofemoral syndrome is complex, but is felt to be due to abnormal patellofemoral (thigh-knee) mechanics. There have been multiple biomechanical factors described as predisposing to this injury. Among the most common are femoral anti-version, "squinting" patella, shallow femoral groove, and excessive Q-angle. However, the amount of exercise maybe of greater importance. The syndrome is often associated with abrupt increases in training mileage and/or intensity of running and hill running is often cited as an exacerbatory factor. The lay term "runner's knee" for patellofemora syndrome is testament to the role of exercise in its development.

The primary symptom of patellofermoral syndrome is pain localized to the region below or around the patella which increases with activity. Running down hill, ascending-descending stairs and prolonged sitting with the knee flexed typically intensify the symptoms. Frequently the individual will complain of instability or of the knee "giving way". A sensation of grating behind the knee cap also may be associated with this syndrome as well as pain on compression of the knee cap. Treatment for this syndrome consists of rest, ice and anti-inflammatory medications.

Sprains and Strains. Although many sprains and strains are acute injuries, they may also result from or be aggravated by overuse and therefore be classified as chronic injuries. Whatever the cause, the symptoms are the same as for acute traumatic sprains and strains, except that symptoms are generally milder. The treatment of these injuries is also the same.

Stress Fractures. Most stress fractures occur to the lower extremities (tibia of the leg and metatarsals of the foot) They occur in two successive stages in response to repetitive overloading of bones during activities such as running, walking or marching. The first stage is a normal physiologic response called "remodelling" in which the body attempts to strengthen stressed bone by removal of old bone and the laying down of new bone. This response is called a "stress reaction" if it is excessive and can be documented with bone scans and occasionally with x-rays. If the stress of weight-bearing continues, the repair process may actually weaken the bone by removing more bone than is laid down. The weakened bone is more susceptible to mechanical failure and the second stage occurs when the weakened bone fractures. Because of the potentially serious consequences of stress reactions of bone, any individual with aching "bone" pain associated with exercise which does not abate in a few days or worsens should be evaluated by an appropriate medical practioner.

INFLAMATION

A basic understanding of inflammation is essential to ensure the proper treatment of musculoskeletal injuries since inflammation underlies most musculoskeletal injuries. Inflammation is the result of a complex series of physiologic reactions to injury. The initial swelling or edema associated with injury results from bleeding and leakage of plasma fluid from the capillaries supplying the injured area. Oozing of fluid from capillaries results from the release of biochemical substances which cause increased vascular permeability. Direct trauma may cause tearing of small blood vessels with resultant hemorrhage causing a bruise. White blood cells are attracted to the site by chemical substances released by damaged tissues. They function to clean up debris from the injury, but their digestive enzymes (lysozymes) may leak into the area damaging healthy tissues contributing to a self-perpetuating cycle of chronic inflammation unless appropriate interventions are initiated.

The end result of the inflammatory process is the classic signs nd symptoms of musculoskeletal inflammation - swelling, redness, loss of function, warmth and pain. These signs and symptoms vary depending on the severity of the injury and whether it is acute or chronic in nature. Excessive and persistent swelling due to inflammation impairs the healing response. Swelling and bleeding also cause pain by mechanical stimulation of free nerve endings. In an attempt to splint (protect) the injured area, secondary muscle spasm may occur which further aggravates the pain from other causes. Thus, one of the major goals of initial treatment of musculoskeletal injuries is to minimize swelling and edema, which will also ameliorate other associated symptoms.

FIRST AID FOR BIOMECHANICAL INJURIES

The purpose of initial treatment of exercise related injuries is to decrease pain, to limit swelling and excessive inflammation which might retard healing, and to prevent further injury. In the setting of acute injuries, these objectives may be accomplished by a combination of rest, ice application, compression, and elevation of the injured part. The acronym "RICE" is used to refer to this treatment protocol (R-rest, I-ice, C-compression, E-elevation). Chronic injuries may require additional treatment modalities, including physical therapy techniques. Anti-inflammatory medication may be helpful for both chronic and acute injuries.

Rest. Severe injuries may require not just immediate rest to prevent further injury but several days to weeks of complete rest for healing. For mild acute and chronic conditions, rest may be relative, requiring only a decrease in the intensity, duration and frequency of exercise. Normal exercise may be resumed when pain-free activity is possible.

Ice (cryotherapy). Ice is applied to reduce swelling, bleeding, inflammation and pain. Cold causes local constriction of blood vessels which limits bleeding and escape of fluid into the area. It also decreases pain by reducing nerve conduction velocity and acts to reduce muscle spasm.

Cold may be applied in the form of ice packs, gel packs, or chemical cold packs. Ice in plastic bags is probably the simplest way to apply cold. Crushed or chipped ice in plastic bags wrapped with an elastic bandage will conform to the contour of the injured part better than ice cubes. Gel packs also conform well to injured areas when wrapped with an elastic pressure bandage, but they lose their cooling properties rapidly. With gel packs care must also be taken to insulate the packs from direct contact with the skin since they may be much colder than ice and can cause frostbite. Chemical cold packs are expensive and are not reusable. Some injuries, especially those to the hands or feet may be immersed in a cold water bath made by adding ice to cold water until a temperature of 13 to 18 degrees C (55 to 65 degrees F) is reached. For chronic injuries ice massage with chunks of ice or ice frozen in paper cups is an effective means to apply cold locally.

Cold therapy is especially crucial in the first 24 to 48 hours following acute injuries. It is also helpful in limiting the inflammatory process in chronic injuries, particularly when daily activities reaggrevate the injury routinely. Cold should be applied for only 20 to 30 minutes at a time, otherwise reflex vascular dilitation may result in increased swelling and bleeding. Acutely cold can be applied for 20 to 30 minutes eahc hour for the first several hours, but later twice a day application is optimal. Cold therapy should not be used for individuals with peripheral circulatory problems or cold hypersensitivity such as Raynaud's syndrome.

Compression. Compression also helps reduce swelling and bleeding. Compression is achieved by the use of elastic wraps and sleeves. Compression and ice may be applied simultaneously by wrapping an ice pack within an elastic bandage over the injured area.

Elevation. Elevation of the injured part decreases blood flow and blood pressure to the injured area and allows gravity to assist drainage from the area thus decreasing swelling. For treatment to be effective an injured extremity should be raised above the level of the heart and placed on a comfortable padded surface.

Heat. Heat is a commonly used treatment modality, which has a limited role in treating musculoskeletol injuries. Heat should not be used for acute injuries. Heat is most beneficial for relief of muscle and joint stiffness after the acute period (first 24 to 48 hours) of injury Furthermore, heat should not be applied when swelling and bleeding persist, and it may aggravate some inflammatory conditions.

ANTI-INFLAMMATORY MEDICATIONS

Anti-inflammatory medications are useful adjuncts in the treatment of acute and chronic exercise related-injuries. These medications are best for relief of chronic inflammatory conditions like tendenitis and bursitis, but they are also good pain relievers. Because aspirin-like compounds decrease the ability of blood to form clots, their use is discouraged for acute injuries while bleeding persists (first 24 hours). Anti-inflammatory medications may cause heart burn (gastritis) and bleeding of the gastrointestinal tract in some individuals, so they should always be taken with meals or snacks. As an, aside acetomenophen is a good pain reliever, but lacks the anti-inflammatory properties of drugs like aspirin.

CONCLUSION

Most training injuries result from inappropriate intensity, duration or frequency of activity for the existing intrinsic condition of the participant or the extrinsic environmental conditions. The use of good judgment and moderation may be sufficient to prevent the majority of exercise related injuries. Training routines should be based on an objective assessment of the individual's physical fitness level and other susceptibility (risk) factors. Periodic re-evaluation of training should be conducted, especially if warning signs of injury such as pain, dysfunction, or decreased performance occur. If these measures fail to prevent injury, prompt first aid should be instituted. Finally, medical attention should be sought whenever the severity of injury merits it or if there is a doubt as to the need for professional medical intervention.

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Table 1: Risk Factors for Musculoskeletal Injuries Associated With Weight-Bearing Physical Training

<u>Extrinsic Risk Factors:</u>

1. Training parameters - increase in intensity, duration or frequency of training.

2. Equipment (shoes, boots) - poor quality/maintenance/fit.

3. Training Surfaces (roads, etc). - hard, irregular, sloping.

<u>Intrinsic Risk Factors:</u>

1. Level of Fitness - low level (aerobic and/or strength).

2. Anatomy - malalignment (flat feet, high arches, bowed legs).

3. Body composition - obesity.

4. Sex - women

5. Age - elderly

6. Prior injury - serious injury (torn cartilage, severe sprain).

7. Musculoskeletal disease - arthritis, disc disease, etc.

Table 2: Effects of Training Frequency and Duration on Incidence of Injury and Improvement in $\dot{V}O_2max$ among previously sedentary males*

Effect of Frequency (30 min/session for 20 weeks)			Effect of Duration (3 days/wk for 20 weeks)		
Days/Wk	Injuries	$\dot{V}O_2max$ (% increase)	Mins/Day	Injuries	$\dot{V}O_2max$ (% increase)
1	0%	8.3%	15	22%	8.6%
3	12%	12.9%	30	24%	16.1%
5	39%	17.4%	45	54%	16.9%

* adapted from Pollock M.L. et al. Effects of frequency and duration of training on attrition and incidence of injury. Med. Sci. Sports, 9(1): 31-36, 1977.

Table 3: Risks of Exercise-Associated Musculoskeletal Injuries for Males and Females

	"Total Fitness"[1] (Military)	Running[2] (Civilian)	
Injury	Seen on Sick call	Reported only	Seen by doctor
Interval	8 weeks	1 Year	
Female Risks	42%	38%	17%
Male Risks	23%	37%	13%
Risk Ratio	1.8*	1	1.3

[1] adapted from Bensel, C.K. Lower extremity disorders among men and women in Army Basic Training and effects of two types of boots. US Army Natick Research, Development and Engineering Laboratories, Natick, MA, Tech Report Natick/tr-83/06, Jan. 1983.

[2] adapted from Kopland, J.P. et al. An epidemiologic study of the benefits and risks of running. J.A.M.A. 248(23):3118-3121, 1982.

* $p<.05$

Table 4: Risks (Percents) of Musculoskeletal (MSK) and Total Casualties for Male (M) and Female (F) Runners

	Boston 1984[1] (M) Cool 7 C (45 F)		Bostonfest 1983[2] (M) Cool 10 C (50 F)	Scheffield 1982[3] (M&F) Warm 24 C (75 F)	
AGE	MSK	TOTAL	TOTAL	MSK	TOTAL
<30	3.4%	6.5%	16.5%	12.4%	19.0%
30-39	2.4%	5.5%	10.3%	10.3%	16.0%
>40	1.5%	3.5%	8.5%	9.1%	13.0%

Extracted From:

1 unpublished data

2 adapted from Jones, B.H. et al. Medical complaints after a cool weather marathon. Phys. Sportsmed. 13(10):103-110, 1985.

3 adapted from Nicholl, J.P., Williams, B.T. Injuries sustained by runners during a popular marathon. Brit. J. Sports Med. 17(1):10-15, 1983.

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